Contacting Nanoclusters with Electroplated Contacts

L. Gurevich, Y. Kervennic, M. Hendriks, H. v.d. Zant and L.P. Kouwenhoven
Department of Applied Sciences and DIMES,
Delft University of Technology
P.O. Box 5046, 2600 GA Delft, The Netherlands

The problem of controllably and reproducibly interfacing 0- and 1-dimensional conductors with macroscopical electrodes is very important for nanoelectronics, both in terms of measurements and applications. We can think of two approaches: either moving a measurement device to the selected nano-object [1, 2] or position the nano-object onto a pre-fabricated measurement device. In this presentation we will address the latter approach, namely, how electroplating can help building reproducible contacts to nanoparticles.

Our technique is based on a combination of electron-beam lithography, electroplating and electrostatic trapping. We start with the preparation of e-beam defined freestanding platinum electrodes with a typical separation 60-80 nm. Then, we electro deposit Pt, Rh or Pd on the electrodes till the gap decreases down to 5-10 nm. As was earlier shown by Morpurgo et al [3], the resistance between the two electrodes can be monitored continuously during electrodeposition. When contact is formed between the electrodes it can be detected and studied.
We have found [4] that a steep drop in this resistance vs electrode-separation is observed already before the electrodes physically touch. Scanning electron micrographs of gaps prove that the inter electrode resistance via the solution provides a reliable measure of the distance between the electrodes and therefore a reliable method to fabricate gaps 10 nm in size and below. These gaps can be used for electrostatic trapping of metallic and semiconducting clusters from solution. We demonstrate full spectrum of room temperature single-electron effects including Coulomb blockade and gate-controlled electron transport on trapped metallic and semiconducting clusters.

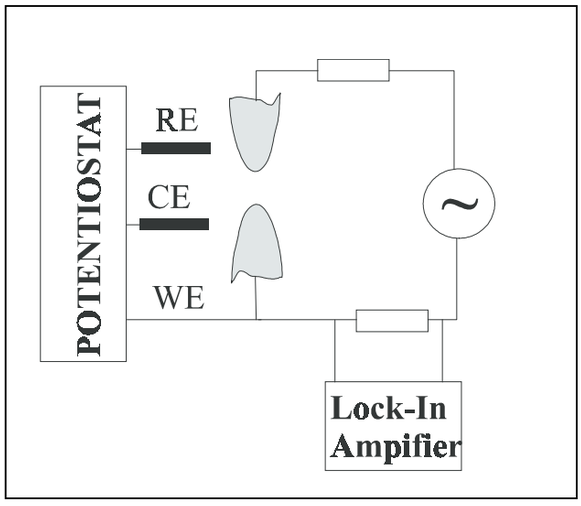

Fig.1 Schematic of the electroplating setup

[1] *Scanning gate spectroscopy on nanoclusters*, L. Gurevich, L. Canali, and L.P. Kouwenhoven, Appl. Phys. Lett. **76**, 384-386 (2000

[2] *The single-particle orbital energy level spectrum of nanocrystalline CdSe quantum dots obtained by Scanning Tunneling Microscopy*, D. Vanmaekelbergh, E.P.A.M. Bakkers, A. Franceschetti, A. Zunger, L. Gurevich, L. Canali, M. Janus, and L.P. Kouwenhoven, Submitted to Phys. Rev. Lett

[3] *Controlled fabrication of metallic electrodes with atomic separation*, A. F. Morpurgo and C. M. Marcus, D. B. Robinson, Appl. Phys. Letters 74, 2084 (1999).

[4] *Electroplated contacts to nanometer sized objects*, Y. Kervennic et al, , to be published.